CLAIMS

What is claimed is:

1. A system for supporting at least one VCR function in a network-based video-on-demand delivery system, comprising:

a player having a user interface that provides at least one user-actuable VCR function initiator, said player being adapted for coupling to a display monitor to supply a video stream to said monitor for playback;

said player maintaining at least one playback pointer that provides information indicative of the current video playback frame;

at least one buffer coupled to said player having an associated loader for downloading video data from said delivery system;

a manager coupled to said player and to said loader for selectively causing said loader to download video data from said delivery system in order to maintain said playback pointer within a predetermined location range within said buffer.

2. The system of claim **1** further comprising a plurality of buffers each being selectively loaded with video data under control of said manager such that at least a one of said buffers contains video data that precedes the current video playback frame.

3. The system of claim **2** wherein each of said buffers has an associated loader responsible for supplying that buffer with downloaded video data.

4. The system of claim **1** wherein said manager includes a feasible point calculation module that assesses whether the destination point resulting from a selected user interaction with said VCR function initiator will result in discontinuous playback.

5. The system of claim **4** wherein said manager is responsive to said feasible point calculation module to modify a requested VCR function such that said function will not result in discontinuous playback.

6. The system of claim **1** wherein said user interface provides VCR functions selected from the group consisting of: jump backward, fast rewind, pause, stop, play, slow motion play, fast forward and jump forward.

7. The system of claim **1** further comprising at least three buffers coupled to said player.

8. The system of claim **1** further comprising at least three buffers coupled to said player, each buffer having an associated loader.

9. The system of claim **1** wherein said manager implements at least two different downloading schemes, including a first scheme for loading said buffer upon startup and a second scheme for loading said buffers after startup.

10. The system of claim **1** further comprising at least three buffers coupled to said player and wherein said manager implements at least two different downloading schemes, including:

(a) a first downloading scheme in which a first one of said buffers is loaded with a first segment and the second and third of said buffers are respectively loaded with second and third segments that each follow the first segment;

(b) a second downloading scheme in which a first one of said buffers is loaded with a first segment, a second of said buffers is loaded with a second segment that precedes the first segment, and a third of said buffers is loaded with a third segment that follows said first segment.

11. A Video-on Demand client system to prefetch segments of video data streams through multiple communications channels of data-centered broadcasting network from a video data server for implementing VCR functions including at least playback the segments, said client system comprising:

at least one loader to download the segments of the video stream from the video data server;

at least one buffer to store the downloaded segments from said loader;

a player to playback the segments read from said buffer, said player being responsive to VCR function commands given through user-interface thereof;

a playback pointer to issue playback commands to said player for designating a playback starting point of the segment in said buffer; and

a prefetch manager to issue prefetch commands to said loader for prefetching the segments from the server based on the current playback point of the segment in said buffer so as to keep the playback point designated by said pointer within predetermined range of said buffer.

12. The client system as in claim **11**, wherein the predetermined range of said buffer is a middle part thereof.

13. The client system as in claim **11**, wherein each number of said loaders and said buffers are respectively at least three.

14. The client system as in claim **11**, the VCR function given through the user-interface of said player including normal play which playbacks the segments of the video streams at normal speed, fast forward which playbacks the segments at multiple times speed as normal play in forward direction, fast backward which playbacks the segments at multiple times speed as the normal play in backward direction, slow forward which playbacks the segment slower than the normal play in forward direction, pause which playbacks stationary with keeping the current playback point, jump forward which jumps directory to the destination point of the segment specified in terms of forward distance relative to the current playback point and resumes the normal play from the jumped point, and jump backward which jumps directory to the destination point of the segment specified in terms of backward distance relative to the current playback point and resumes the normal play from the jumped point.

15. The client system as in claim **11**, wherein according to size of the broadcasting segment through the channels of the network from the server to the client, said playback pointer designates the feasible playback starting point for a destination frame point p of the segment designated by VCR function commands.

16. The client system as in claim **15**, where

- k is defined as natural number;
- b(k) is defined as a beginning frame point of segment No. k;
- e(k) is defined as an end frame point of segment No. k;
- c(k) is defined as a current broadcasting frame point of segment No. k;
- K is defined as numbers of channels and divided into segments of a set of video data streams of each video of length;
- point value of b(k) equals to 0, (1 <= k <= K);
- condition (a): the destination point p is located at or before broadcasting point c(k) of the segment k broadcasting in channel k; and
- condition (b): the size of the current broadcasting segment k equals to the size of next segment k+1,

wherein

when the conditions (a) and (b) are satisfied, if frames between the destination point p and c(k) is in the buffer, then the point p is the feasible point, otherwise the later nearest point q that frames between points of q and c(k) are in the buffer is the feasible point having smallest point value.

17. The client system as in claim **15**, where

• k is defined as natural number;

• b(k) is defined as a beginning frame point of segment No. k;

• e(k) is defined as an end frame point of segment No. k;

• c(k) is defined as a current broadcasting frame point of segment No. k;

• K is defined as numbers of channels and divided into segments of a set of video data streams of each video of length;

• point value of b(k) equals to 0 as an offset value, (1 <= k <= K);

• condition (a): the destination point p is located at or before broadcasting point c(k) of the segment k broadcasting in channel k;

• condition (c): the size of the current broadcasting segment k is half of size of the next segment k+1 and the size of the next two segments k+1 and k+2; and

• condition (d): the point value of c(k) equals to the point value of c(k+1),

wherein

when the conditions (a), (c) and (d) are satisfied,

if both frames between the destination point p and

c(k) and frames between the point b(k+1) and c(k+1) are in the buffer, then the point p is the feasible point,

otherwise:

if frames between the points of b(k+1) and c(k+1) are in the buffer, then the later nearest point q that frames between q and c(k) is in the buffer is the feasible point having smallest point value,

if frames between the points of b(k+1) and c(k+1) are not in the buffer, then the later nearest point q that frames between the points q and c(k+1) is in the buffer are the feasible point having smallest point value.

18. The client system as in claim **15**, where

- k is defined as natural number;
- b(k) is defined as a beginning frame point of segment No. k;
- e(k) is defined as an end frame point of segment No. k;
- c(k) is defined as a current broadcasting frame point of segment No. k;
- K is defined as numbers of channels and divided into segments of a set of video data streams of each video of length;
- point value of b(k) equals to 0 as an offset value, (1 <= k <= K);
- condition (a): the destination point p is located at or before broadcasting point c(k) of the segment k broadcasting in channel k;
- condition (c): the size of the current broadcasting segment k is half of size of the next segment k+1 and the size of the next two segments k+1 and k+2; and
- condition (e): the point value of c(k) does not equals to the point value of c(k+1),

wherein

when the conditions (a), (c) and (e) are satisfied,

if both frames between the destination point p and

c(k) are in the buffer, then the point p is the feasible point, otherwise the later nearest point q that frames between points of q and c(k) are in the buffer is the feasible point having smallest point value.

19. The client system as in claim **15**, where

• k is defined as natural number;

• b(k) is defined as a beginning frame point of segment No. k;

• e(k) is defined as an end frame point of segment No. k;

• c(k) is defined as a current broadcasting frame point of segment No. k;

• K is defined as numbers of channels and divided into segments of a set of video data streams of each video of length;

• point value of b(k) equals to 0 as an offset value, (1 <= k <= K);

• condition (a): the destination point p is located at or before broadcasting point c(k) of the segment k broadcasting in channel k;

• condition (f): the size of the current broadcasting segment k is half of size of the next segment k+1 and the size of the next segments k+1 is half of size of its next segment k+2; and

• condition (g): the point value of c(k) equals to the both point values of c(k+1) and c(k+2),

wherein

when the conditions (a), (f) and (g) are satisfied,

if frames between the destination point p and c(k), frames

between the point b(k+1) and c(k+1), and frames between the point b(k+2) and c(k+2) are in the buffer, then the point p is the feasible point,

otherwise:

if frames between the point b(k+1) and c(k+1), and frames between the point b(k+2) and c(k+2)are in the buffer, then the later nearest point q that frames between q and c(k) is in the buffer is the feasible point having smallest point value,

if frames between the points of b(k+1) and c(k+1) are not all in the buffer, and frames between the point b(k+2) and c(k+2)are in the buffer, then the later nearest point q that frames between q and c(k+1) is in the buffer is the feasible point having smallest point value,

if frames between the points of b(k+1) and c(k+1) are not in the buffer, then the later nearest point q that frames between the points q and c(k+2) are in the buffer is the feasible point having smallest point value.

20. The client system as in claim **15**, where

• k is defined as natural number;

• b(k) is defined as a beginning frame point of segment No. k;

• e(k) is defined as an end frame point of segment No. k;

• c(k) is defined as a current broadcasting frame point of segment No. k;

• K is defined as numbers of channels and divided into segments of a set of video data streams of each video of length;

• point value of b(k) equals to 0 as an offset value, (1 <= k <= K);

• condition (a): the destination point p is located at or before broadcasting point c(k) of the segment k broadcasting in channel k;

• condition (f): the size of the current broadcasting segment k is half of size of the next segment k+1 and the size of the next segments k+1 is half of size of its next segment k+2; and

• condition (h): the point value of c(k) equals to the both point values of c(k+1) and does not equal to c(k+2),

wherein

when the conditions (a), (f) and (h) are satisfied,

if frames between the destination point p and c(k),

and frames between the point b(k+1) and c(k+1) are in the buffer, then the point p is the feasible point, otherwise:

if frames between the point b(k+1) and c(k+1) are in the buffer, then the later nearest point q that frames between q and c(k) is in the buffer is the feasible point having smallest point value,

if frames between the points of b(k+1) and c(k+1) are not all in the buffer, then the later nearest point q that frames between q and c(k+1) is in the buffer is the feasible point having smallest point value.

21. The client system as in claim 15, where

• k is defined as natural number;

• b(k) is defined as a beginning frame point of segment No. k;

• e(k) is defined as an end frame point of segment No. k;

• c(k) is defined as a current broadcasting frame point of segment No. k;

• K is defined as numbers of channels and divided into segments of a set of video data streams of each video of length;

• point value of b(k) equals to 0 as an offset value, (1 <= k <= K);

• condition (a): the destination point p is located at or before broadcasting point c(k) of the segment k broadcasting in channel k;

• condition (f): the size of the current broadcasting segment k is half of size of the next segment k+1 and the size of the next segments k+1 is half of size of its next segment k+2; and

• condition (i): the point value of c(k) equals to the point values of c(k+2) and does not equal to c(k+1),

wherein

when the conditions (a), (f) and (i) are satisfied,

if frames between the destination point p and c(k), and

frames between the point b(k+2) and c(k+2) are in the buffer, then the point p is the feasible point,

otherwise:

if frames between the point b(k+2) and c(k+2) are in the buffer, then the later nearest point q that frames between q and c(k) is in the buffer is the feasible point having smallest point value,

if frames between the points of b(k+2) and c(k+2) are not all in the buffer, then the later nearest point q that frames between q and c(k+2) is in the buffer is the feasible point having smallest point value.

22. The client system as in claim **15**, where

• k is defined as natural number;

• b(k) is defined as a beginning frame point of segment No. k;

• e(k) is defined as an end frame point of segment No. k;

• c(k) is defined as a current broadcasting frame point of segment No. k;

• K is defined as numbers of channels and divided into segments of a set of video data streams of each video of length;

• point value of b(k) equals to 0 as an offset value, (1 <= k <= K);

• condition (a): the destination point p is located at or before broadcasting point c(k) of the segment k broadcasting in channel k;

• condition (f): the size of the current broadcasting segment k is half of size of the next segment k+1 and the size of the next segments k+1 is half of size of its next segment k+2; and

• condition (j): the point value of c(k) does not equal to the both point values of c(k+1) and c(k+2),

wherein

when the conditions (a), (f) and (j) are satisfied,

if frames between the destination point p and c(k) are in the buffer, then the point p is the feasible point,

otherwise the later nearest point q that frames between q and c(k) is in the buffer is the feasible point having smallest point value.

23. The client system as in claim **15**, where

• k is defined as natural number;

• b(k) is defined as a beginning frame point of segment No. k;

• e(k) is defined as an end frame point of segment No. k;

• c(k) is defined as a current broadcasting frame point of segment No. k;

• K is defined as numbers of channels and divided into segments of a set of video data streams of each video of length;

• point value of b(k) equals to 0 as an offset value, (1 <= k <= K);

• condition (k): the destination point p is located after the current broadcasting point c (k) of the segment k broadcasting in channel k, wherein

when the conditions (k) is satisfied, frames between the destination point p and c(k) are considered as frames between p and e(k-1) and frames between b(k) and c(k) so that the destination point p is considered to be located at or before broadcasting point c(k) of the segment k broadcasting in channel k.

24. A method of demanding segments of video data streams by a Video-on Demand client system through multiple communications channels of data-centered broadcasting network from a video data server for implementing VCR functions including at least playback the segments by a player of the client system, said method comprising the steps of:

(a) downloading the segments of the video stream from the video server to at least one loader;

(b) storing the downloaded segments of the loader at least one buffer for being read to playback by a player therefrom;

(c) issuing at least playback command to the player for designating a playback starting point of the segment in the buffer; and

(d) issuing prefetch commands to the loader for prefetching the segments from the server based on the current playback point of the segment so as to keep the playback point designated by said pointer within predetermined range of a buffer.

25. A method for supplying segments of video data streams to Video-on-Demand clients through multiple communications channels of data-centered broadcasting network from a video data server in a Video-on-Demand system, said method comprising:

establishing the communications channel between the client and the server;

dividing each video data stream into multiple sequential segments in accordance with equation: SIZE = {f(N)*L}/{sigma function of f(J), J=1~K};

where:

- SIZE is defined as size of segment No. N;
- N is defined as natural number;
- f(N) is defined as 2 to the power {N – (N/M)};
- M is defined as a number of channels being able to download the segments simultaneously;
- L is defined as length of a set of data streams of each video;
- J is defined as natural number; and
- K is defined as numbers of channels and divided into segments of a set of video data streams of each video of length L,

and

transmitting the divided segments of each video multiple times to the clients through the multiple channels from the server.

26. The method of claim **25** further comprising the steps of :

receiving at the Video-on-Demand client the transmitted segments from the server;

playing the segments at the Video-on-Demand client;

and

concurrently with playing and receiving, storing the transmitted sequential segments at the Video-on-Demand client.

27. A Video-on Demand broadcasting system, said system comprising:

a video data server to supply video data streams to multiple communications channels of data-centered broadcasting network;

Video-on-Demand clients through to receive segments of the video data streams through the network

wherein after establishing the communications channel between the client and the server,

said server having dividing means for dividing each video data stream into multiple sequential segments in accordance with equation:

SIZE = {f(N)*L}/{sigma function of f(J), J=1~K};

where:

- SIZE is defined as size of segment No. N;
- N is defined as natural number;
- f(N) is defined as 2 to the power {N – (N/M)};
- M is defined as a number of channels being able to download the segments simultaneously;
- L is defined as length of a set of data streams of each video;

• J is defined as natural number; and

• K is defined as numbers of channels and

divided into segments of a set of video data streams of each video of length L,

and

transmitting means for transmitting the divided segments of each video multiple times to the clients through the multiple channels.

28. The system of claim **27** wherein the client having receiving means for receiving the transmitted segments from the server and playing means for playing the segments, and concurrently with playing and receiving, storing means for storing the transmitted sequential segments.

29. A video data server of the system as in claim **27**.

30. A Video-on-Demand client of the system as in claims **27**.

31. A Video-on-Demand client of the system as in claims **28**.